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Feasibility of Irrigating With Water From SCS Floodwater-Retarding Impoundments

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Feasibility of Irrigating With Water From SCS Floodwater-Retarding Impoundments

By Russell R. Schoof and Harold Price[1]

ABSTRACT

The use of water for supplemental irrigation was inventoried at 16 U.S. Soil Conservation Service impoundments in a 1,130-square-mile reach of the Washita River in southwestern Oklahoma in 1977. Nearly 500 acre-feet of water was applied to over 800 acres during the growing season. All of the farmers involved in the study reported that there had been enough water for the acreage under irrigation. Calculations revealed that in 136 completed floodwater-retarding impoundments within the study reach, there were more than 13,000 acre-feet of potential water storage in sediment pools. When water was released from one impoundment on each of two streams at initial rates of 6.8 and 1.17 cubic feet per second to determine transmission losses, 75 and 44 percent of the water reached gaging stations 6 and 4.5 miles downstream. Also included in this publication are formulas for calculating the amount of water each landowner can legally use from a full reservoir. Index terms: irrigation, water rights, Oklahoma SCS floodwater-retarding impoundments, Washita River Basin, water-storage potential, water transmission loss.

INTRODUCTION

Droughts during the summer growing season are frequent in western Oklahoma. Precipitation records at Fort Sill, Comanche County, in southwestern Oklahoma show that in only 11 of 100 years did precipitation exceed 2.5 inches during each month from May through August. Even in some of those "wet" years there were periods of drought that stressed crops and reduced production. Table 1 shows the probability of various amounts of precipitation occurring during each month at Fort Sill.

Where enough water of suitable quality is available, irrigation can increase production, stabilize income, and eliminate the possibility of forced sale of livestock at depressed prices during an extended drought. With irrigation, there is a potential for double cropping at least every other year. However, the feasibility of irrigating must be determined on an individual basis, and a farmer should carefully analyze the economics of such a project before making the necessary investment (Arnold and Back 1960, 1962; Sloggett 1970). The labor requirement and recent increases in the cost of energy must both be considered. Some additional factors to consider include dependability of the water supply, acquisition of water rights, transmission loss from supply to point of use, and a benefit-cost analysis.

This study was conducted to determine the feasibility of irrigating with water stored in sediment pools of floodwater-retarding impoundments constructed by the U.S. Soil Conservation Service (SCS). We studied only the 1,130-square-mile reach of the Washita River between Anadarko (Caddo County) and Alex (Grady County), Okla. (fig. 1), but the

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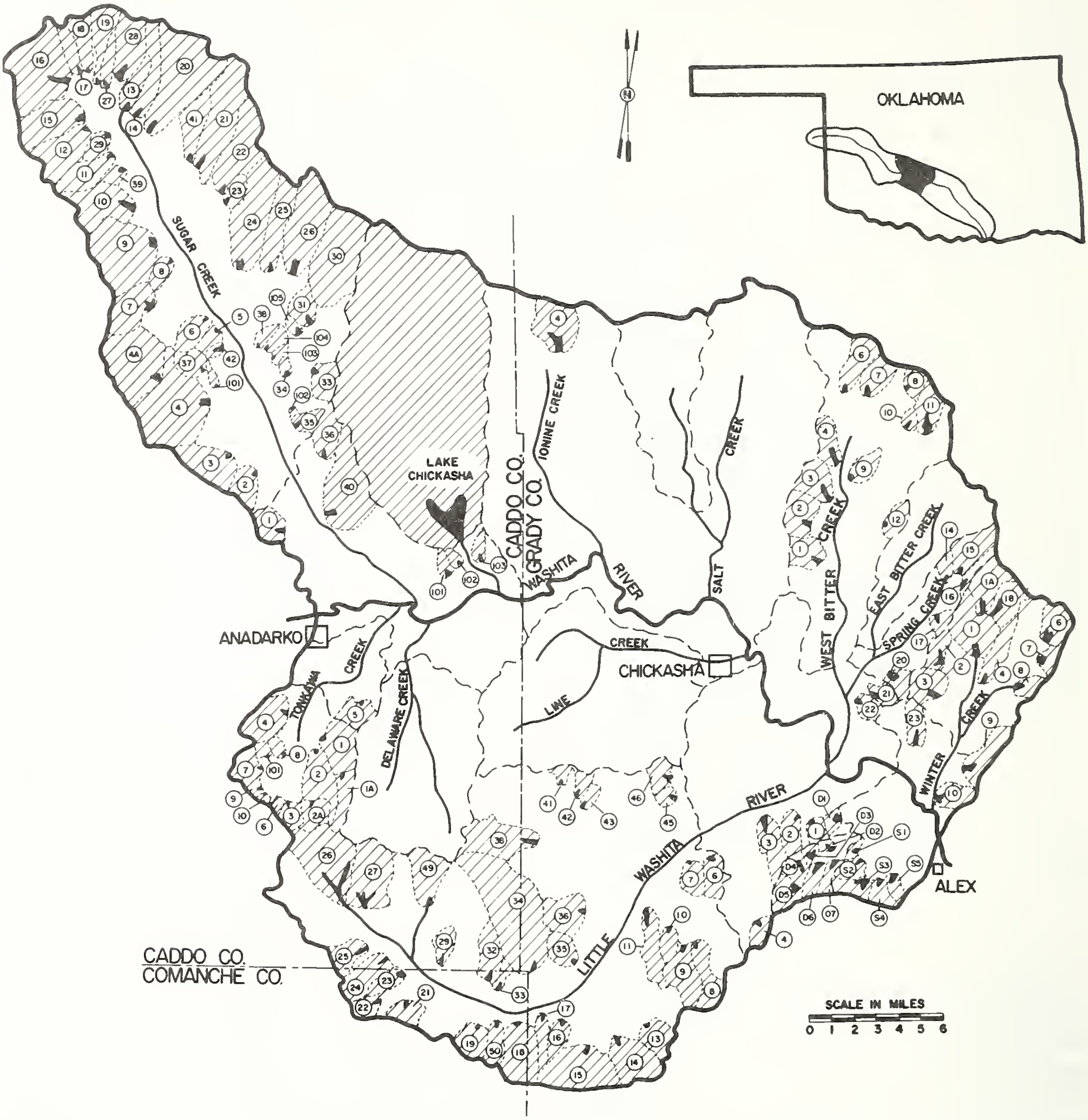

FIGURE 1. — Study reach of Washita River Basin. Shaded areas represent areas controlled by impoundment structures. Small black areas represent sediment pools. Circled numbers represent impoundment sites.

Table 1. — Monthly precipitation probabilities based on a 100-year record at Fort Sill, Okla.

Precipitation (inches)	Probability (percent) for month of —											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.0	51	55	69	82	96	90	76	76	82	75	59	59
2.0	17	25	36	59	87	73	52	58	62	54	31	32
4.0	3	2	3	25	59	36	24	18	33	29	11	5
6.0	0	0	1	8	31	14	7	8	12	12	4	0
8.0	0	0	0	2	15	6	2	2	5	8	0	0

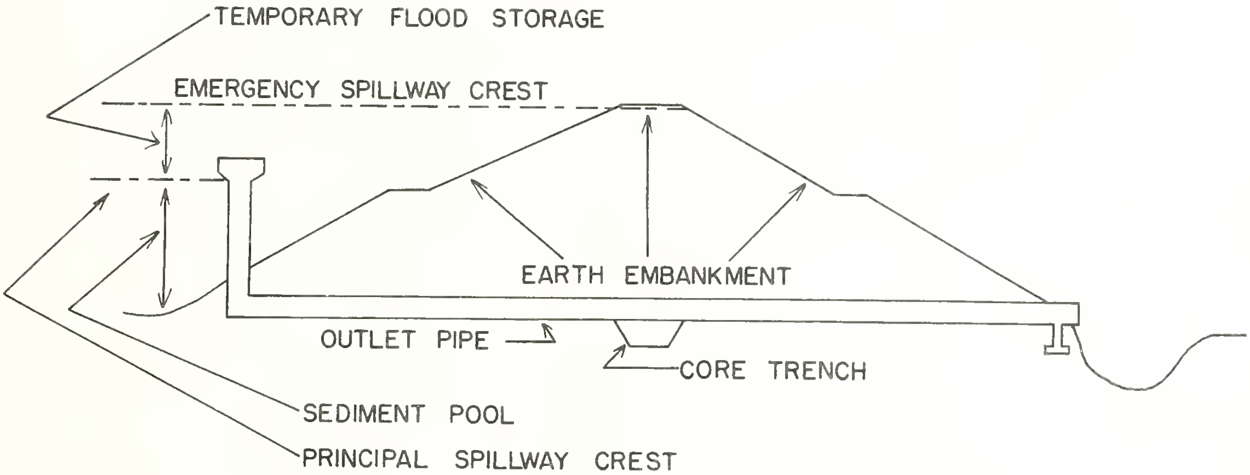

FIGURE 2. — Cross section of typical floodwater-retarding structure.

results are applicable to a much larger area, including parts of Texas, Kansas, and Oklahoma.

A typical floodwater-retarding structure consists of an earthen dam, a drop-inlet principal spillway, and an open-channel emergency spillway (fig. 2). The principal spillway is ungated and automatically limits the rate at which water can flow from the reservoir. The space in the reservoir between the elevation of the principal and emergency spillways is used for temporary storage of floodwater. The sediment pool lies below the principal spillway and contains the water that has potential for irrigation use.

We attempted to determine (1) the extent of irrigation with water from the impoundments within the Washita River study reach, (2) the water-storage potential of the impoundments within this reach, (3) the transmission loss of water released from an impoundment and permitted to flow downstream to a point of use, and (4) the requirements regarding water rights for landowners seeking to use water from the impoundments and the methods involved in determining the amount of water each landowner can use from a full reservoir.

METHODS AND RESULTS

Use of water from SCS impoundments for irrigation was inventoried in 1977 and included kinds of crops irrigated, number of acres irrigated, number of water applications, and amounts of water applied (table 2 and fig. 1). Water was used for irrigation from only two SCS impoundments in Grady County, sites 1 and 6 on West Bitter Creek, from which soybeans, cotton, and corn were irrigated. In Caddo County, water was used from 14 SCS impoundments, all on Sugar Creek. The principal crop irrigated was peanuts. Nearly 500 acre-feet of water was applied to slightly over 800 acres of the Sugar Creek watershed during

Table 2. — Inventory of irrigation from floodwater-retarding impoundments in Grady and Caddo Counties, Okla., 1977

Site	Crop	Area (acres)	No. water applications	Total water applied: Inches	Total water applied: Acre-feet
		Grady County: West Bitter Creek			
1	Soybeans	[1]22.0	(2)	(2)	(2)
	Soybeans	[1]13.0	(2)	(2)	(2)
	Soybeans	60.0	3.0	10.5	52.5
6	Cotton	96.0	(2)	(2)	(2)
	Corn	20.0	(2)	(2)	(2)
Total		231.0	...	...	52.5
		Caddo County: Sugar Creek			
1	Peanuts	150	2.5	5	62.5
3	Peanuts	25	3	10.5	21.9
	Alfafa	20	2	8	13.3
4	Peanuts	19	3	10.5	16.6
9	Peanuts	11.7	1.5	2.2	2.2
	Peanuts	24	2.4	7.1	14.2
11	Peanuts	35	2	.3	11.0
14	Peanuts	11	3	7.5	6.9
	Cotton	3	2	5	1.2
	Watermelon	12	1	2.5	2.5
16	Watermelon	30	.5	1.5	3.7
18	Peanuts	40	5	10	33.3
19	Peanuts	70	4	8	46.7
20	Peanuts	27	5	10	22.5
	Peanuts	57	4	8	38.0
21	Peanuts	82	5	7.5	51.2
	Peanuts	67	5	10	55.8
22	Peanuts	23	4	12	23.0
	Peanuts	30	5	10	25.0
	Lovegrass	20	1	3	5.0
24	Sudangrass	25	2	5	10.4
	Bermudagrass	25	2	5	10.4
29	Peanuts	20	2	5	8.3
Total		826.7			485.6

[1]Flooded.
[2]Data not available.

the 1977 growing season. All of the farmers involved reported that there had been enough water for the acreage under irrigation. No water was used from any of the impoundments in the Little Washita River Basin in Comanche County.

In calculations involving 136 completed floodwater-retarding impoundments within the study reach (1978), we determined that there were more than 13,000 acre-feet of potential water storage in the sediment pools. However, the smaller pools generally contain only enough water for irrigating large family gardens.

Most of the impoundments are one-half mile or more upstream from land suitable for irrigation. Therefore, the water would have to be released down the channel to the point of use or transported through a pipeline. Water was released from one impoundment on Winter Creek and one impoundment on the Spring Creek branch of East Bitter Creek, and flow was measured at points downstream to determine transmission losses.

The landowner at site 7 on Winter Creek (fig. 1) released water from that impoundment to kill the Eurasian water milfoil, *Myriophyllum spicatum.* The initial release rate was 6.8 cubic feet per second, and 75 percent of the water reached the Winter Creek gaging station 6 miles downstream. The base flow at the gaging station before the release was slightly greater than 1 cubic foot per second. In the test conducted on the Spring Creek branch

of East Bitter Creek, water was released from impoundment site 17 for 7 days. The initial release rate was 1.17 cubic feet per second. However, water milfoil partially blocked the release opening and had reduced the release rate to 0.55 cubic foot per second by the seventh day. A total release of 10.3 acre-feet of water was made from the impoundment, but only 44 percent of the water reached the East Bitter Creek gaging station 4.5 miles downstream. Base flow at the gaging station was 0.53 cubic foot per second. The flow was impeded by beaver dams in a one-fourth-mile reach of lower Spring Creek. At the Standridge pumping site 6.8 miles downstream from site 17, the average flow was increased from 2.52 to 2.66 acre-feet per day, or only 5.5 percent.

A landowner must own part of the flood pool, dam, spillway, or sediment pool to obtain the legal right to use part of the water. In Oklahoma, the State water law is administered by the Oklahoma Water Resources Board, and the computations below concerning allocation of water rights were obtained from the Board.[2]

In order to determine a share percentage for each owner, a total value (TV) is computed for the impoundment by

$$TV=0.25(FP)+0.75(DS)+1.00(SP),$$

where FP is the flood pool area outside the sediment pool, DS is the dam and spillway area, and SP is the sediment pool area (all in acres). A proportionate value (PV) can then be determined for each property owner by

$$PV=0.25(FP')+0.75(DS')+1.00(SP'),$$

where the prime sign designates the area of the flood pool, dam, spillway, or sediment pool owned by the property owner under construction. To find each owner's share percentage, divide his PV by TV and multiply by 100. Multiplying the share percentage times the volume of stored water gives the acre-feet of storage each property owner can use from a full reservoir.

DISCUSSION

Some of the impoundments, especially in Grady County, have incoming base flow during much of a year with normal rainfall. However, many of the impoundments in Caddo County have little, if any, incoming base flow. The extent of base flow depends on rainfall, season of year, geology, and geomorphology (land forms).

The amount of water available for irrigation from a floodwater-retarding impoundment varies from year to year, depending on the amount and intensity of rainfall. The physiographic characteristics of watershed drainage into an impoundment are also important. Those that influence runoff are type of soil, slope of the terrain, vegetative cover, and storage in farm ponds. Generally, very little runoff can be expected from timbered areas in southwestern Oklahoma. There are mathematical models (U.S. Soil Conservation Service 1969, Holton and Lopez 1971) that can be used with a computer to estimate the amount of runoff that could be expected into an impoundment and thus the amount of water that would be available for irrigation.

An important consideration before investing in irrigation equipment is what the probability is of the water supply failing to meet the demand placed on it. Assume that the water supply and acreage irrigated are such that the supply would meet the demand in all years unless rainfall was below average for 3 or more consecutive years. From the plot of annual rainfall shown in figure 3 for Fort Sill, where the average annual rainfall was 30.55 inches, one can see that the supply would fail to meet the demand during 13 of the 100 years. The probability of failure under given conditions could be determined more accurately by computing a continuous water budget for the impoundment in question. However, accuracy of the prediction would still depend largely on accuracy of the determined relationship between rainfall and runoff for the contributing watershed.

Annual loss of stored water by evaporation and seepage averages 60 to 65 inches in Grady and Caddo Counties. If the stored water were used for irrigation, the volume of loss would be reduced because there would be less surface area and depth of water.

In areas where the annual rainfall is less than about 30 inches, there may not be enough flow through existing impoundments to keep the pools flushed free of the saline water left by evaporation. There is also a problem in many impoundments with Eurasian water milfoil growth, which restricts use of pools for recreational purposes. Use of the water for irrigation would limit the increase in salinity of the pool and also temporarily kill much

[2] Unpublished data.

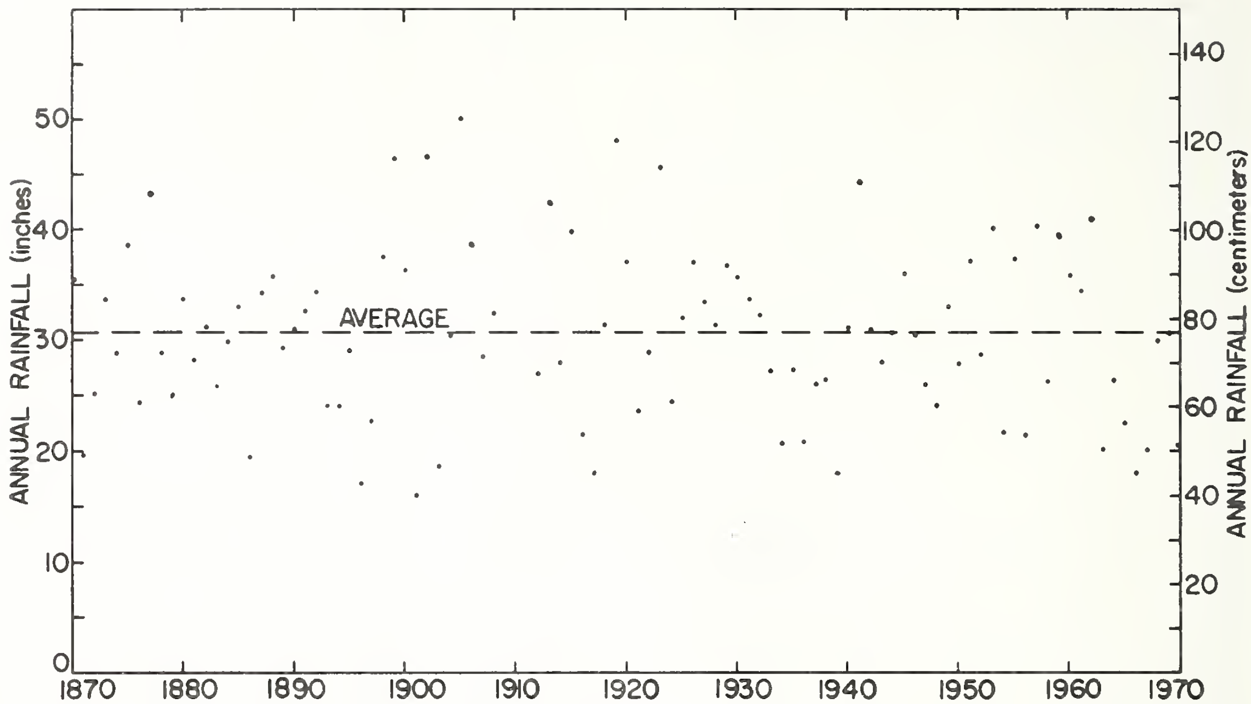

FIGURE 3. — Annual rainfall for 100-year period at Fort Sill, Okla.

of the milfoil as the pool water level is lowered. Thus, there may be some fringe benefits if the water is used for irrigation.

The cost of labor appears to be the primary impediment to irrigation projects. Another problem associated with using water from floodwater-retarding impoundments is that the impoundment owners may not own land suitable for irrigation. The irrigable land may lie some distance downstream. Thus, if the water is ever to be used for irrigation, cost of the water must be negotiated between the owners and the downstream users. Conveyance efficiency could be increased to near 100 percent by installing a pipeline, but that is expensive. In July 1979 the cost, including installation of polyvinyl chloride pipe per foot, was about $3 for 6-inch-diameter pipe, $4.50 for 8-inch-diameter pipe, and $6 for 10-inch-diameter pipe.

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